



{In Archive} Re: ACTION REQ'D: Five-week review of PAG Manual

Stuart Walker to: Sara DeCair

05/15/2007 06:04 PM

Cc: Doug Ammon, Colby Stanton, Elizabeth Southerland, Juan Reyes

Bcc: RobinM Anderson, Charles Sands

From: Stuart Walker/DC/USEPA/US
To: Sara DeCair/DC/USEPA/US@EPA,
Cc: Doug Ammon/DC/USEPA/US@EPA, Colby Stanton/DC/USEPA/US@EPA, Elizabeth Southerland/DC/USEPA/US@EPA, Juan Reyes/DC/USEPA/US@EPA
Bcc: RobinM Anderson/DC/USEPA/US@EPA, Charles Sands/DC/USEPA/US@EPA

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Hi Sara,

Thanks for providing us an opportunity to review the latest draft of the ORIA PAGs. OSRTI does not have any showstoppers. We request that you let us review a ~~redline/strikeout~~-version of the next draft after you incorporate comments from the workgroup.

Since, this is the first draft of the ORIA PAG to include concentrations for the drinking water and food interdiction PAGs, we are submitting revised substantive comments on both those PAGs from our comments on the last draft. Our comments on both the drinking water and food interdiction PAGs include a comparison of the PAG concentrations to risk based concentrations, and in the case of the drinking water PAGs, MCLs. These comparisons are similar to the comments I sent Ed Tupin 3-4-2004 on an early draft of the water PAGs.



OSRTI comment on ORIA PAGsApril2007v1.doc

Below is further explanation of the analysis discussed in the comments on the water and food PAGs.

Water PAGs

Chronic effects

I put together 3 Lotus 123 Tables comparing ORIA's PAG concentrations to MCLs and concentrations corresponding to a 1×10^{-4} cancer risk. I used MCLs and 10^{-4} since these are measures EPA utilizes when making decisions about providing bottled water during emergencies involving class A carcinogens. I noticed that a number of the ORIA PAG concentrations are thousands of times higher than the MCLs or 1×10^{-4} (a few are over a hundred thousand times higher). This is not evident without looking at the concentrations since the MCL for most radionuclides is 4 mrem/yr and the PAG is 500 mrem/yr. However, I understand that different science may have something to do with it since the MCL is based on ICRP 2 methodology and the PAG is ICRP 60/72 methodology, however the 1×10^{-4} risk based concentrations are also based on ICRP 60/72.

Here is an explanation of the comparison tables I put together on the water PAGs and the 3 tables themselves.



2007ExplainCompareTables.pdf 2007CompareTable_byRisk.123 2007CompareTable_byMCL.123 2007CompareTable_byRad.123

Subchronic effects

It also appears that drinking water at the PAG concentrations for Te-129 and Te-127 may lead to subchronic (acute) effects acute following exposures of a day or a week. In a population, one should see

some express of acute effects (not deaths) above 0.25 Gy (25 rad) - that is, vomiting, fever etc. The Te-129 absorbed dose at 1 week was 1.8 Gy (180 rad) for 14 L intake. For these two radionuclides, an acute radiation syndrome (ARS) involving the GI-tract is indicated. Acute dose coefficients for a 30 d period were calculated for the adult using the AcutDose. This analysis focused only on the 16 radionuclides where drinking water at the PAG concentration for 1 week or less would exceed the amount of radioactivity received from drinking a 1×10^{-4} cancer risk level assuming 70 years of exposure.

Food PAGs

I also put together 3 Lotus 123 Tables comparing ORIA's food PAG concentrations that were adopted from FDA to concentrations corresponding to a 1×10^{-4} cancer risk. I used 10^{-4} since the food interdiction situation is somewhat analogous to the decision of when to provide drinking water. I noticed that some of the ORIA PAG concentrations are hundreds, even thousands of times higher than the MCLs or 1×10^{-4} .

Here is an explanation of the comparison tables I put together on the food PAGs and the 3 tables themselves.



2007ExplainCompareFOODTables.pdf



2007CompareFoodTable_byRad.123

Sara DeCair/DC/USEPA/US

Sara DeCair/DC/USEPA/US

04/10/2007 10:26 AM

To Andrew.Wallo@eh.doe.gov, cmw6@cdc.gov, cym3@cdc.gov, Kenneth.Wierman@dhs.gov, man@cdrh.fda.gov, pxm@nrc.gov, paul.nelson@dtra.mil, pxs@cdrh.fda.gov, stanton.colby@epa.gov, Sara DeCair/DC/USEPA/US@EPA, stephen.domotor@eh.doe.gov, sam2@nrc.gov, Dan.Wilcox@dhs.gov, Vanessa.Quinn@dhs.gov, william.cunningham@nist.gov, walker.stuart@epa.gov, ammon.doug@epa.gov, schumann.jean@epa.gov, Ferris.John@dol.gov, druedy@endyna.com, itasker@endyna.com, siddhanti@endyna.com, asa4@CDC.GOV, Jack.Patterson@rss.usda.gov, John Cardarelli/CI/USEPA/US@EPA, Scott Hudson/CI/USEPA/US@EPA, Colleen Petullo/LV/USEPA/US@EPA, Susan Stahle/DC/USEPA/US@EPA, ksteves@kdhe.state.ks.us, jim_hardeman@dnr.state.ga.us, debra.mcbaugh@doh.wa.gov, elzermam@michigan.gov, yalek@michigan.gov, Jessica.Wieder/DC/USEPA/US@EPA, dschneider@scainc.com, Robert Dye/ARTD/R7/USEPA/US@EPA, CharlesA Hooper/ARTD/R7/USEPA/US@EPA, Roger Goodman/DC/USEPA/US@EPA, craig.conklin@dhs.gov, John Mackinney/DC/USEPA/US@EPA, tdkraus@sandia.gov, Mike Boyd/DC/USEPA/US@EPA, Neal Nelson/DC/USEPA/US@EPA, Lowell Ralston/DC/USEPA/US@EPA, Rick Poeton/R10/USEPA/US@EPA, boyd.wesley@epa.gov, Scott Telofski/MTG/USEPA/US@EPA, Roger Goodman/DC/USEPA/US@EPA
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Subject ACTION REQ'D: Five-week review of PAG Manual

PAGs Reviewers;

It is time for the final federal review, via FRPCC, of the PAG Manual prior to going into the Federal Register for public comment! This is a SHOWSTOPPERS ONLY review and we are asking for you to obtain your agency or department's (or your AA-ship's within EPA) buy-in on this Manual so we can release it. The five weeks start on April 10th and end on May 15th. Your showstopper comments are due no later than May 15th.

A showstopper is defined as a statement or concept that your agency or department sees as so problematic that we cannot release the Manual for public comment. Since this is the last of several rounds of review, we hope there will not be any such issues. Note that I will be checking in with you over the next few weeks to check on your progress and to see if you have any questions or potential showstoppers.

After this review and our incorporation of any final changes, I will submit the final draft Manual to my management in the Office of Air and Radiation along with the final draft FR Notice of Availability for approval. We plan to issue the FR Notice in June and provide a 60-day comment period.

To access the document:

Go to the contractor's FTP site at: <ftp://205.158.69.157/>

User name: clients Password: welcometoendyna

In the EPA ORIA folder, you will find both Word and PDF versions -- I suggest you print from the Word version with 'View, Markup' turned OFF.

Attachments:

- A suggested re-organization for Chapter 6 that may improve readability
- Comment form
- Draft FR Notice of Availability (please provide any input you have, this is not subject to the 'showstoppers only' rule!)

Thank you for all your input and support on this project, and I look forward to hearing from all of you,

Sara D. DeCair, Health Physicist
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Center for Radiological Emergency Preparedness,
Prevention, and Response
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[attachment "A suggested layout for Chapter 6.doc" deleted by Stuart Walker/DC/USEPA/US] [attachment "Showstoppers Comment Form.doc" deleted by Stuart Walker/DC/USEPA/US] [attachment "FR Notice draft 3-27-2007.doc" deleted by Stuart Walker/DC/USEPA/US]

COMMENT FORM

Point of Contact (name/phone number/email): Stuart Walker/USEPA - OSRTI/703-603-8748/walker.stuart@epa.gov

Page #	Line #	Comment Type	Comment
GEN			<p>We have no Critical comments on the April 2007 draft. We are making several substantive comments, either new comments or revisions of previous comments due to our ability to evaluate the concentration tables in version of the draft PAGs. We would also suggest you send around a final redline/strikeout version to see if there are any objections to any of the revised language.</p>
4-1 to 4-8		Substantive	<p>We realize that this issue was decided for the DHS RDD/IND PAG Federal Register notice, however we are making this comment because this ORIA document covers a wider scope of response actions and this draft of the ORIA document includes radionuclide concentrations corresponding to the PAG.</p> <p>The 500 mrem/yr Drinking Water PAG should be deleted or replaced with EPA CERCLA Removal Action Level (RAL) concentrations. OSWER Directive 9360.1-02 "Final Guidance on Numeric Removal Action Levels for Contaminated Drinking Water Sites" recommends providing alternative drinking water supplies during CERCLA removal actions when water is contaminated above a concentration corresponding to the MCL or 1×10^{-4} cancer risk using EPA's Office of Water methodology (e.g., 70 period of exposure and cancer morbidity), whichever allows the greater concentration. In general, a 500 mrem/yr drinking water PAG would correspond to a risk of 2.01×10^{-2} cancer mortality risk using 70 period of exposure, suggesting the PAG would allow the public to drink water at concentrations 200 times greater than EPA's guidance for emergency removals. However, for most of the radionuclides the PAG would be much more than 200 times the RAL, and up to 765,000 times greater for one radionuclide. The PAGs are up to 7.65 million times greater than the MLC. Providing alternative drinking water in the intermediate phase should not be that difficult, the government has been doing it at sites and disaster areas for years. Please see attached analysis comparing ORIA drinking water PAGs to RAL (1×10^{-4} and MCL) concentrations.</p> <p>Also, for two of the ORIA Drinking Water PAG concentrations it appears that ingestion of the water may result in greater than 25 Rad absorbed dose, resulting in subchronic effects such as vomiting and fever.</p>

Page #	Line #	Comment Type	Comment
5-1 to 5-17		Substantive	<p>We realize that this issue was decided for the DHS RDD/IND PAG Federal Register notice, however we are making this comment because this ORIA document covers a wider scope of response actions actions and this draft of the ORIA document includes radionuclide concentrations corresponding to the PAG.</p> <p>The 500 mrem/yr Food Interdiction PAG based on FDA DILs should be deleted or replaced with a protective value similar to EPA RALs such as 1×10^{-4} concentrations over 70 years. In general, a 500 mrem/yr Food Interdiction PAG would correspond to a risk of 4.23×10^{-4} cancer morbidity risk for each year of exposure for members of public who would have this contaminated food shipped out to them, a risk of 2.01×10^{-2} cancer mortality risk using 70 period of exposure. This could greatly expand the population dose as a result of the WMD incident if the public accepted the food, and potentially damage the uncontaminated agricultural industry in that region if the public becomes alarmed that radioactive food is being shipped around the country. Considering the food surplus in this country, the document should not use such a high dose number as a starting point. In addition, FDA DILs only apply during first year of an accident, starting with the early phase (see pg. 8 of "Accidental Radioactive Contamination of Human Food and Animal Feeds: Recommendations for State and Local Agencies, August 13, 1998). In general, a 500 mrem/yr food PAG would correspond to a risk of 2.01×10^{-2} cancer mortality risk using 70 period of exposure, suggesting the PAG would allow the public to ingest food at concentrations 200 times greater than EPA's guidance for drinking water during emergency removals. OSRTI's analysis of FDA DILs with concentrations corresponding to 1×10^{-4} indicate that the DILs are generally tens or hundreds of times higher than the 10^{-4} concentrations, and in a few instances thousands of times higher. In a few other instances, they are actually lower. Please see attached analysis comparing FDA food PAGs to RAL-like (1×10^{-4}) concentrations.</p>

PROCEDURES FOR COMPLETING THE COMMENT FORM

1. In the Page #, and Line # columns, insert the relevant page and line number(s) pertaining to the comment.

Note: For general comments that do not correspond to a specific page number, place the word 'GEN' under the page # column.

2. In the Comment Type column, indicate whether the comment is **Critical**, **Substantive**, or **Administrative** in nature. If Critical comments are not incorporated, you will be informed as to the reason for the decision.

3. In the Comment column, place only one comment per row: and provide comment, recommendation (**specific language**) and rationale. Because of the short timeframe for incorporation of comments, only specific language suggestions (deletions, additions, or changes) will be considered.

Explanation of “3 Tables Comparing 500 mrem/yr DRL Concentrations to MCL or 1×10^{-4} Concentrations”

There are 3 Lotus 123 Tables provided. They are sorted by:

1. Radionuclide, in the order provided in the draft PAGs chapter
2. Risk, in order of the DRL posing the highest multiple of a 1×10^{-4} cancer incidence risk
3. MCLs, in order of the DRL posing the greatest multiple of the MCL

Rationale for Tables 2 and 3:

The CERCLA document most analogous to this PAG would be the “Final Guidance on Numeric Removal Action Levels for Contaminated Drinking Water Sites” OSWER 9360.1-02, October 25, 1993, which discusses when short-term risks from contaminated drinking water wells are high enough to warrant providing alternative (replacement) drinking water supplies. This document may be found at the following website:

http://www.epa.gov/superfund/resources/gwdocs/ral_guid.pdf

For class A carcinogens that do not have DWELs or longer-term HA’s, like radionuclides, this guidance says to provide drinking water if the concentrations are above 1×10^{-4} lifetime risk (using OW methodology of 70 year exposure), or the MCL, if the MCL is greater than 1×10^{-4} lifetime risk.

Following are explanations of the information in the 3 tables.

Radionuclide column:

- Lists of radionuclides taken from Table 4.1 in the April 2007 draft ORIA PAGs document, which is found in Chapter 4 on drinking water PAGs.
- Radionuclides that are bolded and their rows are yellow highlighted were considered radionuclides of most concern for RDDs, INDs, or nuclear accidents in writeups from ORIA and Army Corps of Engineers.
- Tables that were put in the same row in Table 4.1 (e.g., Ru/Rh-106) have been broken out to facilitate comparisons between DRLs and 1×10^{-4} risk levels.

DRLs with Rad Decay column:

- Taken from Table 4.1. These were the DRLs listed as the appropriate to use for the PAG and thus were used for comparison purposes with MCL and risk concentrations used for RALs.

1x10⁻⁴ using OW Methods column:

- For those radionuclides that **do** have a value listed in the column “OW risk associated with MCL”, these values are based on the rounded off values in the “OW risk...” column then a hand calculation on the value in the “MCLs” column to approximate the concentration that corresponds to a 1×10^{-4} cancer incidence risk using OW methodology. Note, OW staff did not create 1×10^{-4} concentrations for these radionuclides.
- For those radionuclides that **do not** have a value listed in the column “OW risk associated with MCL”, these values are from OW.

MCLs Column:

- MCLs from OW implementation guide.
- Uranium MCLs are in terms of mass (micrograms per liter), not activity (picoCuries per liter). The 30 micrograms per liter MCL for the uranium element was converted to an activity for each isotope. The UMTRCA groundwater standard of 30 pCi/l for U-234 and U-238 combined was listed here for U-234 since it is a potential ARAR at CERCLA sites.

OW Risk Associated with MCL

- Provided in NODA for MCLs and/or regulatory support document. Note that some MCLs that are in OW implementation guide did not appear in the support documents, which is why SF rather than OW risk is provided.

1x10⁻⁴ using SF & 70 yrs

- Risk estimate developed using CERCLA rad PRG calculator, by changing “Tap water” exposure scenario defaults as follows: time of exposure from 30 years to 70 years; target risk from 1×10^{-6} to 1×10^{-4} .

Comparison of DRL to OW/SF 10⁻⁴:

- Shows by a factor of #, how much DRL is greater than 1×10^{-4} risk level concentration.
- What this means
 - if value is 70, then **1 year** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)
 - if value is 840, then **1 month** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)
 - if value is 25,550, then **1 day** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)
 - if value is 127,750, then drinking **1 glass** of water (12 ounces) at DRL value will equal amount of exposure of drinking water with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)
 - For example, drinking a very tiny amount of water of approximately 1 teaspoon of water with Te-129 at the DRL concentration would result in an exposure that corresponds to drinking liters of water per day for 70 years at the 1×10^{-4} level.

Comparison of DRL to MCL

- Shows by a factor of #, how much DRL is greater than MCL concentration.
- What this means
 - if value is 70, then **1 year** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years)
 - if value is 840, then **1 month** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years)
 - if value is 25,550, then **1 day** of drinking 2 liters of water at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years)
 - if value is 127,750, then drinking **1 glass** of water (12 ounces) at DRL value will equal amount of exposure of drinking water at the MCL level for a lifetime (70 years).
 - For example, drinking a very tiny amount of water of approximately 1/10 of a teaspoon of water with Te-129 at the DRL concentration would result in an exposure that corresponds to drinking 2 liters of water per day for 70 years at the MCL level.

Sheet1

**Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations
Sorted by OW/SF 1 x 10-4 Cancer Incidence Risk**

Radionuclide	Concentrations in pCi/L				Comparison shows DRL is X times 10-4 or MCL value		
	DRLs with Rad Decay only	1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
Te-129	153000000000	20000	2000	1x10-5		765000	7650000
Te-127	712000000	2970	900	3x10-5		239730.6397	791111.1111
Pm-151	54100000				453	119426.0486	
Te-131m	19200000		200		247	77732.79352	96000
W-187	74700000	1000	200	2x10-5		74700	373500
Np-239	24900000		300		397	62720.40302	83000
Ce-143	30400000	500	100	2x10-5		60800	304000
La-140	13800000	300	60	2x10-5		46000	230000
Pm-149	21300000	500	100	2x10-5		42600	213000
Cs-134	11300	0.266666667	80	3x10-2		42375	141.25
Sb-127	7280000				202	36039.60396	
Au-198	16900000	500	100	2x10-5		33800	169000
Y-90	6530000	198	60	3x10-5		32979.79798	108833.3333
Bi-210	7110000	219	15			32465.75342	474000
Te-132	3780000		90		120	31500	42000
Co-58	909000	33.33333333	300	9x10-4		27270	3030
Mo-99	28100000	1500	600	4x10-5		18733.33333	46833.33333
Sb-126	1540000				184	8369.565217	
Sn-125	1580000	198	60	3x10-5		7979.79798	26333.33333
Nd-147	3940000	500	200	4x10-5		7880	19700
Th-227	277000	41	15			6756.097561	18466.66667
Ba-140	1410000	225	90	4x10-5		6266.666667	15666.66667
V-48	1460000				249	5863.453815	
P-32	1370000	300	30	1x10-5		4566.666667	45666.66667
Yb-169	2060000				510	4039.215686	
P-33	7500000				2080	3605.769231	
I-131	267000	75	3	4x10-6		3560	89000
Rb-86	892000	300	600	2x10-4		2973.333333	1486.666667
Cs-136	1160000	400	800	2x10-4		2900	1450
Ce-141	2030000	750	300	4x10-5		2706.666667	6766.666667

Sheet1

Cr-51	43700000	19800	6000	3x10-5	2207.070707	7283.333333
Te-129m	468000	225	90	4x10-5	2080	5200
Hf-181	984000	500	200	4x10-5	1968	4920
Ru-103	1620000	1000	200	2x10-5	1620	8100
In-114m	233000	150	60	4x10-5	1553.333333	3883.333333
Y-91	341000	225	90	4x10-5	1515.555556	3788.888889
Fe-59	591000	400	200	5x10-5	1477.5	2955
Tb-160	415000	330	100	3x10-5	1257.575758	4150
Zr-95	773000	660	200	3x10-5	1171.212121	3865
Nb-95	2260000				1940	1164.948454
Sb-124	311000	300	60	2x10-5	1036.666667	5183.333333
Tm-170	320000	330	100	3x10-5	969.6969697	3200
Ir-192	477000	500	100	2x10-5	954	4770
Eu-154	94300	99	60	6x10-5	952.5252525	1571.666667
I-132	3780000	4500	90	2x10-6	840	42000
Sn-113	620000	750	300	4x10-5	826.6666667	2066.666667
Sc-46	397000	500	100	2x10-5	794	3970
Ge-68	216000				293	737.2013652
Pm-147	807000		600		1210	666.9421488
I-125	51200				80	640
Cm-242	31200	51	15			611.7647059
Ta-182	297000	500	100	2x10-5		594
Sn-123	201000				340	591.1764706
Se-75	170000	300	900	3x10-4		566.6666667
Gd-153	1070000	1980	600	3x10-5		540.4040404
Hg-203	529000	990	60	6x10-4		534.3434343
Ru-106	36500	75	30	4x10-5		486.6666667
Sn-126	38700				80	483.75
Ca-45	513000	1110	10	9x10-7		462.1621622
Pm-145	1630000				3650	446.5753425
Ce-144	43300	99	30	3x10-5		437.3737374
Ba-133	125000				300	416.6666667
Ti-44	32000				80	400
Sm-151	1890000	5000	1000	2x10-5		378
Ho-166m	93500				254	368.1102362
Sr-89	363000	1000	20	2x10-6		363
K-40	30000				83	361.4457831

Sheet1

Ag-110m	106000	297	90	3x10-5	356.9023569	1177.777778
Eu-155	607000	1980	600	3x10-5	306.5656566	1011.6666667
Po-210	333	1.1	15		302.7272727	22.2
Co-60	57600	200	100	5x10-5		288
Tl-204	170000	600	300	5x10-5	283.3333333	566.6666667
Zn-65	75400	300	300	1x10-4	251.3333333	251.3333333
Mn-54	375000	1500	300	2x10-5		250
Ni-63	1220000	5000	50	1x10-6		244
Tc-99	288000	1260	900	7x10-5	228.5714286	320
Cl-36	199000	875	700	8x10-5	227.4285714	284.2857143
Fe-55	631000	2800	2000	7x10-5	225.3571429	315.5
Bi-207	147000	660	200	3x10-5	222.7272727	735
Cd-109	120000	600	600	1x10-4		200
Nb-94	106000				613	172.9200653
Sr-90	6730	40	8	2x10-5		168.25
Na-22	66100	400	400	1x10-4		165.25
C-14	319000	2000	2000	1x10-4		159.5
Cs-137	13800	100	200	2x10-4		138
U-235	3960		65		29	136.5517241
Pb-210	270				2	135
Ra-226	659	5	5	1x10-4		131.8
U-238	4150		10		32	129.6875
S-35	731000	6250	500	8x10-6		116.96
Cd-113m	8260				71	116.3380282
Pu-236	2400	26	15			92.30769231
H-3	4540000	50000	20000	4x10-5		90.8
Zr-93	167000	2200	2000	9x10-5		75.90909091
I-129	1750	25	1	4x10-6		70
Eu-152	139000	2000	200	1x10-5		69.5
Cm-244	1530	23	15			66.52173913
Cm-243	1260	21	15			60
Ac-227	585				10	58.5
Cf-252	2210	39	15			56.66666667
Np-237	1730	32	15			147.3333333
Pu-238	815				16	50.9375
Pu-240	737				15	49.13333333
Pu-239	737				15	49.13333333

Sheet1

Pu-242	777			16	48.5625	
Am-243	912	19	15		48	60.8
Am-241	908	19	15		47.78947368	60.53333333
Cm-246	894	19	15		47.05263158	59.6
Cm-245	890	19	15		46.84210526	59.33333333
Pu-241	39900		300	1160	34.39655172	133
Am-242m	971			29	33.48275862	
Pr-144	53300			25200	2.115079365	
Th-232	0	19	15		0	0
Th-228	0	18	15		0	0
Th-230	0	21	15		0	0
U-233	0		290000	28	0	0
U-234	0		190000	29	0	0
Pa-231	0	8	15		0	0
U-232	0		640000000	7	0	0
U-234	0	UMTRCA GW	30	29	0	0
Ba-137	13800					
Rh-106	36500					

**Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations
Sorted by MCL**

Radionuclide	Concentrations in pCi/L					Comparison shows DRL is X times 10-4 or MCL value	
	DRLs with Rad Decay only	1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
Te-129	153000000000	20000	2000	1x10-5		765000	7650000
Te-127	712000000	2970	900	3x10-5		239730.6397	791111.1111
Bi-210	7110000	219	15			32465.75342	474000
W-187	74700000	1000	200	2x10-5		74700	373500
Ce-143	30400000	500	100	2x10-5		60800	304000
La-140	13800000	300	60	2x10-5		46000	230000
Pm-149	21300000	500	100	2x10-5		42600	213000
Au-198	16900000	500	100	2x10-5		33800	169000
Y-90	6530000	198	60	3x10-5		32979.79798	108833.3333
Te-131m	19200000		200		247	77732.79352	96000
I-131	267000	75	3	4x10-6		3560	89000
Np-239	24900000		300		397	62720.40302	83000
Ca-45	513000	1110	10	9x10-7		462.1621622	51300
Mo-99	28100000	1500	600	4x10-5		18733.33333	46833.33333
P-32	1370000	300	30	1x10-5		4566.666667	45666.66667
I-132	3780000	4500	90	2x10-6		840	42000
Te-132	3780000		90		120	31500	42000
Sn-125	1580000	198	60	3x10-5		7979.79798	26333.33333
Ni-63	1220000	5000	50	1x10-6		244	24400
Nd-147	3940000	500	200	4x10-5		7880	19700
Th-227	277000	41	15			6756.097561	18466.66667
Sr-89	363000	1000	20	2x10-6		363	18150
Ba-140	1410000	225	90	4x10-5		6266.666667	15666.66667
Hg-203	529000	990	60	6x10-4		534.3434343	8816.666667
Ru-103	1620000	1000	200	2x10-5		1620	8100
Cr-51	43700000	19800	6000	3x10-5		2207.070707	7283.333333
Ce-141	2030000	750	300	4x10-5		2706.666667	6766.666667
Te-129m	468000	225	90	4x10-5		2080	5200
Sb-124	311000	300	60	2x10-5		1036.666667	5183.333333
Hf-181	984000	500	200	4x10-5		1968	4920
Ir-192	477000	500	100	2x10-5		954	4770
Tb-160	415000	330	100	3x10-5		1257.575758	4150
Sc-46	397000	500	100	2x10-5		794	3970

In-114m	233000	150	60	4x10-5	1553.333333	3883.333333
Zr-95	773000	660	200	3x10-5	1171.212121	3865
Y-91	341000	225	90	4x10-5	1515.555556	3788.888889
Tm-170	320000	330	100	3x10-5	969.6969697	3200
Co-58	909000	33.33333333	300	9x10-4	27270	3030
Ta-182	297000	500	100	2x10-5	594	2970
Fe-59	591000	400	200	5x10-5	1477.5	2955
Cm-242	31200	51	15		611.7647059	2080
Sn-113	620000	750	300	4x10-5	826.6666667	2066.666667
Sm-151	1890000	5000	1000	2x10-5	378	1890
Gd-153	1070000	1980	600	3x10-5	540.4040404	1783.333333
I-129	1750	25	1	4x10-6	70	1750
Eu-154	94300	99	60	6x10-5	952.5252525	1571.666667
Rb-86	892000	300	600	2x10-4	2973.333333	1486.666667
S-35	731000	6250	500	8x10-6	116.96	1462
Cs-136	1160000	400	800	2x10-4	2900	1450
Ce-144	43300	99	30	3x10-5	437.3737374	1443.333333
Pm-147	807000		600		1210	666.9421488
Mn-54	375000	1500	300	2x10-5	250	1250
Ru-106	36500	75	30	4x10-5	486.6666667	1216.666667
Ag-110m	106000	297	90	3x10-5	356.9023569	1177.777778
Eu-155	607000	1980	600	3x10-5	306.5656566	1011.666667
Sr-90	6730	40	8	2x10-5	168.25	841.25
Bi-207	147000	660	200	3x10-5	222.7272727	735
Eu-152	139000	2000	200	1x10-5	69.5	695
Co-60	57600	200	100	5x10-5	288	576
TI-204	170000	600	300	5x10-5	283.3333333	566.6666667
U-238	4150		10		32	129.6875
Tc-99	288000	1260	900	7x10-5	228.5714286	320
Fe-55	631000	2800	2000	7x10-5	225.3571429	315.5
Cl-36	199000	875	700	8x10-5	227.4285714	284.2857143
Zn-65	75400	300	300	1x10-4	251.3333333	251.3333333
H-3	4540000	50000	20000	4x10-5	90.8	227
Cd-109	120000	600	600	1x10-4	200	200
Se-75	170000	300	900	3x10-4	566.6666667	188.8888889
Na-22	66100	400	400	1x10-4	165.25	165.25
Pu-236	2400	26	15		92.30769231	160
C-14	319000	2000	2000	1x10-4	159.5	159.5
Cf-252	2210	39	15		56.666666667	147.3333333
Cs-134	11300	0.2666666667	80	3x10-2	42375	141.25

Pu-241	39900		300			1160	34.39655172	133
Ra-226	659	5	5	1x10-4			131.8	131.8
Np-237	1730	32	15				54.0625	115.33333333
Cm-244	1530	23	15				66.52173913	102
Cm-243	1260	21	15				60	84
Zr-93	167000	2200	2000	9x10-5			75.90909091	83.5
Cs-137	13800	100	200	2x10-4			138	69
U-235	3960		65			29	136.5517241	60.92307692
Am-243	912	19	15				48	60.8
Am-241	908	19	15				47.78947368	60.533333333
Cm-246	894	19	15				47.05263158	59.6
Cm-245	890	19	15				46.84210526	59.333333333
Po-210	333	1.1	15				302.7272727	22.2
Th-228	0	18	15				0	0
U-233	0		290000			28	0	0
Th-232	0	19	15				0	0
Pa-231	0	8	15				0	0
U-232	0		640000000			7	0	0
U-234	0		190000			29	0	0
Th-230	0	21	15				0	0
U-234	0	UMTRCA GW	30			29	0	0
Ti-44	32000					80	400	
K-40	30000					83	361.4457831	
V-48	1460000					249	5863.453815	
Pu-238	815					16	50.9375	
Pu-240	737					15	49.13333333	
Pu-242	777					16	48.5625	
Am-242m	971					29	33.48275862	
P-33	7500000					2080	3605.769231	
Pu-239	737					15	49.13333333	
Pm-151	54100000					453	119426.0486	
Pm-145	1630000					3650	446.5753425	
Sb-126	1540000					184	8369.565217	
Pr-144	53300					25200	2.115079365	
Ba-137	13800							
Ho-166m	93500					254	368.1102362	
I-125	51200					80	640	
Yb-169	2060000					510	4039.215686	
Sb-127	7280000					202	36039.60396	
Sn-123	201000					340	591.1764706	

Sheet1

Sn-126	38700	80	483.75
Ge-68	216000	293	737.2013652
Cd-113m	8260	71	116.3380282
Rh-106	36500		
Nb-95	2260000	1940	1164.948454
Pb-210	270	2	135
Nb-94	106000	613	172.9200653
Ac-227	585	10	58.5
Ba-133	125000	300	416.6666667

Sheet1

**Table Comparing 500 mrem/yr DRL Concentrations to MCL or 1 x 10-4 Concentrations
Sorted by Radionuclide**

Radionuclide	Concentrations in pCi/L				Comparison shows DRL is X times 10-4 or MCL value		
	DRLs with Rad Decay only	1x10-4 using OW Methods	MCLs	OW Risk Associated with MCL	1x10-4 using SF & 70yrs	Comparison of DRL to OW/SF 10-4	Comparison of DRL to MCL
H-3	4540000	50000	20000	4x10-5		90.8	227
C-14	319000	2000	2000	1x10-4		159.5	159.5
Na-22	66100	400	400	1x10-4		165.25	165.25
P-32	1370000	300	30	1x10-5		4566.666667	45666.66667
P-33	7500000				2080	3605.769231	
S-35	731000	6250	500	8x10-6		116.96	1462
Cl-36	199000	875	700	8x10-5		227.4285714	284.2857143
K-40	30000				83	361.4457831	
Ca-45	513000	1110	10	9x10-7		462.1621622	51300
Sc-46	397000	500	100	2x10-5		794	3970
Ti-44	32000				80	400	
V-48	1460000				249	5863.453815	
Cr-51	43700000	19800	6000	3x10-5		2207.070707	7283.333333
Mn-54	375000	1500	300	2x10-5		250	1250
Fe-55	631000	2800	2000	7x10-5		225.3571429	315.5
Fe-59	591000	400	200	5x10-5		1477.5	2955
Co-58	909000	33.33333333	300	9x10-4		27270	3030
Co-60	57600	200	100	5x10-5		288	576
Ni-63	1220000	5000	50	1x10-6		244	24400
Zn-65	75400	300	300	1x10-4		251.3333333	251.3333333
Ge-68	216000				293	737.2013652	
Se-75	170000	300	900	3x10-4		566.6666667	188.8888889
Rb-86	892000	300	600	2x10-4		2973.333333	1486.666667
Sr-89	363000	1000	20	2x10-6		363	18150
Sr-90	6730	40	8	2x10-5		168.25	841.25
Y-90	6530000	198	60	3x10-5		32979.79798	108833.3333
Y-91	341000	225	90	4x10-5		1515.555556	3788.888889
Zr-93	167000	2200	2000	9x10-5		75.90909091	83.5
Zr-95	773000	660	200	3x10-5		1171.212121	3865
Nb-94	106000				613	172.9200653	

Sheet1

Nb-95	2260000				1940	1164.948454	
Mo-99	28100000	1500	600	4x10-5		18733.33333	46833.33333
Tc-99	288000	1260	900	7x10-5		228.5714286	320
Ru-103	1620000	1000	200	2x10-5		1620	8100
Ru-106	36500	75	30	4x10-5		486.6666667	1216.666667
Rh-106	36500						
Ag-110m	106000	297	90	3x10-5		356.9023569	1177.777778
Cd-109	120000	600	600	1x10-4		200	200
Cd-113m	8260				71	116.3380282	
In-114m	233000	150	60	4x10-5		1553.333333	3883.333333
Sn-113	620000	750	300	4x10-5		826.6666667	2066.666667
Sn-123	201000				340	591.1764706	
Sn-125	1580000	198	60	3x10-5		7979.79798	26333.33333
Sn-126	38700				80	483.75	
Sb-124	311000	300	60	2x10-5		1036.666667	5183.333333
Sb-126	1540000				184	8369.565217	
Sb-127	7280000				202	36039.60396	
Te-127	712000000	2970	900	3x10-5		239730.6397	791111.1111
Te-129	15300000000	20000	2000	1x10-5		765000	7650000
Te-129m	468000	225	90	4x10-5		2080	5200
Te-131m	19200000		200		247	77732.79352	96000
Te-132	3780000		90		120	31500	42000
I-132	3780000	4500	90	2x10-6		840	42000
I-125	51200				80	640	
I-129	1750	25	1	4x10-6		70	1750
I-131	267000	75	3	4x10-6		3560	89000
Cs-134	11300	0.266666667	80	3x10-2		42375	141.25
Cs-136	1160000	400	800	2x10-4		2900	1450
Cs-137	13800	100	200	2x10-4		138	69
Ba-137	13800						
Ba-133	125000				300	416.6666667	
Ba-140	1410000	225	90	4x10-5		6266.666667	15666.66667
La-140	13800000	300	60	2x10-5		46000	230000
Ce-141	2030000	750	300	4x10-5		2706.666667	6766.666667
Ce-143	30400000	500	100	2x10-5		60800	304000
Ce-144	43300	99	30	3x10-5		437.3737374	1443.333333
Pr-144	53300				25200	2.115079365	

Sheet1

Nd-147	3940000	500	200	4x10-5		7880	19700
Pm-145	1630000				3650	446.5753425	
Pm-147	807000		600		1210	666.9421488	1345
Pm-149	21300000	500	100	2x10-5		42600	213000
Pm-151	54100000				453	119426.0486	
Sm-151	1890000	5000	1000	2x10-5		378	1890
Eu-152	139000	2000	200	1x10-5		69.5	695
Eu-154	94300	99	60	6x10-5		952.5252525	1571.666667
Eu-155	607000	1980	600	3x10-5		306.5656566	1011.666667
Gd-153	1070000	1980	600	3x10-5		540.4040404	1783.333333
Tb-160	415000	330	100	3x10-5		1257.575758	4150
Ho-166m	93500				254	368.1102362	
Tm-170	320000	330	100	3x10-5		969.6969697	3200
Yb-169	2060000				510	4039.215686	
Hf-181	984000	500	200	4x10-5		1968	4920
Ta-182	297000	500	100	2x10-5		594	2970
W-187	74700000	1000	200	2x10-5		74700	373500
Ir-192	477000	500	100	2x10-5		954	4770
Au-198	16900000	500	100	2x10-5		33800	169000
Hg-203	529000	990	60	6x10-4		534.3434343	8816.666667
Tl-204	170000	600	300	5x10-5		283.3333333	566.6666667
Pb-210	270				2	135	
Bi-207	147000	660	200	3x10-5		222.7272727	735
Bi-210	7110000	219	15			32465.75342	474000
Po-210	333	1.1	15			302.7272727	22.2
Ra-226	659	5	5	1x10-4		131.8	131.8
Ac-227	585				10	58.5	
Th-227	277000	41	15			6756.097561	18466.66667
Th-228	0	18	15			0	0
Th-230	0	21	15			0	0
Th-232	0	19	15			0	0
Pa-231	0	8	15			0	0
U-232	0		640000000			7	0
U-233	0		290000			28	0
U-234	0		190000			29	0
U-234	0	UMTRCA GW	30			29	0
U-235	3960		65		29	136.5517241	60.92307692

Sheet1

U-238	4150		10		32	129.6875	415
Np-237	1730	32	15			54.0625	115.33333333
Np-239	24900000		300		397	62720.40302	83000
Pu-236	2400	26	15			92.30769231	160
Pu-238	815				16	50.9375	
Pu-239	737				15	49.13333333	
Pu-240	737				15	49.13333333	
Pu-241	39900		300		1160	34.39655172	133
Pu-242	777				16	48.5625	
Am-241	908	19	15			47.78947368	60.53333333
Am-242m	971				29	33.48275862	
Am-243	912	19	15			48	60.8
Cm-242	31200	51	15			611.7647059	2080
Cm-243	1260	21	15			60	84
Cm-244	1530	23	15			66.52173913	102
Cm-245	890	19	15			46.84210526	59.33333333
Cm-246	894	19	15			47.05263158	59.6
Cf-252	2210	39	15			56.66666667	147.3333333

Explanation of “3 Tables Comparing 500 mrem/yr DIL Food Concentrations to 1×10^{-4} Concentrations”

There are 3 Lotus 123 Tables provided. They are:

1. “CompareFoodTable” which takes the food ingestion parameters out of the PRG Agricultural scenario to plug a revised all food and drink ingestion parameter into the PRG Fish scenario. Also included is a value for Tap water ingestion.
2. “CompareFoodTable_Conversion” takes modified Fish PRG results (1×10^{-4} target risk, 70 year period of exposure, and the fish ingestion changed to 3,012.49 grams per day to represent all food and liquid intake, and 1,012.49 to represent food and liquid intake without water). These modified Fish PRG results are converted into Bq/kg, and also provided as if only 30% of the food was contaminated.
3. “CompareFoodTable_Radionclide”, compares the FDA DIL concentrations to the 1×10^{-4} concentrations, both with 30% and 100% of the food and liquids considered contaminated, and with water and without water included in the liquids.

Rationale for Comparison Table:

The CERCLA document most analogous to this PAG would be the “Final Guidance on Numeric Removal Action Levels for Contaminated Drinking Water Sites” OSWER 9360.1-02, October 25, 1993, which discusses when short-term risks from contaminated drinking water wells are high enough to warrant providing alternative (replacement) drinking water supplies. This document may be found at the following website:

http://www.epa.gov/superfund/resources/gwdocs/ral_guid.pdf

For class A carcinogens that do not have DWELs or longer-term HA’s, like radionuclides, this guidance says to provide drinking water if the concentrations are above 1×10^{-4} lifetime risk (using OW methodology of 70 year exposure).

Following are explanations of the information in the 3 tables.

Radionuclide column:

- Lists of radionuclides taken from Tables D-6 and E-7 in the April 2007 draft ORIA PAGs document, which is found in Chapter 5 on food interdiction PAGs.
- Radionuclides that have their rows **highlighted** are group by FDA into a single DIL, where the sum of the fraction rule applies.
- Radionuclides that were grouped by FDA (e.g., Cs-134/Cs-137) have been broken out to facilitate comparisons between DILs and 1×10^{-4} risk levels.

Comparison of DIL to SF 10⁻⁴:

4. Shows by a factor of #, how much DRL is greater or lesser than 1×10^{-4} risk level concentration.
5. What this means
 - if values is less than 1, then the DIL is more protective than the 1×10^{-4} risk level concentration.
 - if value is 1, then **70 years** of ingesting food at the DIL value will equal amount of exposure of ingesting food with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)
 - if value is 70, then **1 year** of ingesting food at the DIL value will equal amount of exposure of ingesting food with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)
 - if value is 840, then **1 month** of ingesting food at the DIL value will equal amount of exposure of ingesting food with a lifetime cancer incidence risk of 1×10^{-4} for a lifetime (70 years)
 - For example, ingesting contaminated food (including water) at the DIL level for Cs-137 and assuming only 30% of your food was contaminated, would result in an exposure that corresponds to ingesting contaminated food at 30% of your diet for 70 years at the 1×10^{-4} level.

Radionuclide	1x10-4 using SF methods with water and 100% food contaminated		1x10-4 using SF methods without water and 100% food contaminated		Conversion from Bq/g to Bq/kg	1x10-4 using SF methods with water and 100% food contaminated		Conversion from Bq/g to Bq/kg	1x10-4 using SF methods without water and 100% food contaminated		Conversion from 100% contamination to 30% Bq/kg	1x10-4 using SF methods with water and 30% food contaminated		1x10-4 using SF methods without water and 30% food contaminated	
	Bq/g	Bq/g	Bq/g	Bq/g		Bq/g	Bq/g		Bq/g	Bq/g		Bq/g	Bq/g	Bq/g	
Sr-90	0.000526	0.00157	1000	0.526		1.57	0.3		1.753333333				5.233333333		
I-131	0.000374	0.00111	1000	0.374		1.11	0.3		1.246666667				3.7		
Cs-134	0.000975	0.0029	1000	0.975		2.9	0.3						3.25		9.666666667
Cs-137	0.00134	0.00399	1000	1.34		3.99	0.3		4.466666667				13.3		
Ru-103	0.00903	0.0269	1000	9.03		26.9	0.3						30.1		89.66666667
Ru-106	0.00082	0.00244	1000	0.82		2.44	0.3		2.733333333				8.133333333		
Pu-238	0.000297	0.000883	1000	0.297		0.883	0.3						0.99		2.943333333
Pu-239	0.000288	0.000857	1000	0.288		0.857	0.3						0.96		2.856666667
Am-241	0.000374	0.00113	1000	0.374		1.13	0.3		1.246666667				3.766666667		
Sr-89	0.00272	0.00811	1000	2.72		8.11	0.3		9.066666667				27.03333333		
Y-91	0.00213	0.00635	1000	2.13		6.35	0.3						7.1		21.16666667
Zr-95	0.00761	0.0226	1000	7.61		22.6	0.3		25.366666667				75.33333333		
Nb-95	0.0142	0.0426	1000	14.2		42.6	0.3		47.33333333				142		
Te-132	0.00205	0.00611	1000	2.05		6.11	0.3		6.833333333				20.36666667		
I-129	0.000156	0.000463	1000	0.156		0.463	0.3						0.52		1.543333333
I-133	0.00114	0.00339	1000	1.14		3.39	0.3						3.8		11.3
Ba-140	0.00231	0.00687	1000	2.31		6.87	0.3						7.7		22.9
Ce-141	0.0074	0.022	1000	7.4		22	0.3		24.666666667				73.33333333		
Ce-144	0.000966	0.00287	1000	0.966		2.87	0.3						3.22		9.566666667
Np-237	0.000551	0.00164	1000	0.551		1.64	0.3		1.836666667				5.466666667		
Np-239	0.00668	0.0199	1000	6.68		19.9	0.3		22.266666667				66.33333333		
Pu-241	0.022	0.0654	1000	22		65.4	0.3		73.33333333				218		
Cm-242	0.000915	0.00272	1000	0.915		2.72	0.3						3.05		9.066666667
Cm-244	0.000464	0.00138	1000	0.464		1.38	0.3		1.546666667				4.6		

Sheet1

Food Pathway	Child input kg/yr	Child exposure period, yrs	Adult input kg/yr	Adult exposure period, yrs	Total Exposure kg	Residential exposure period, years	Age Averaged Ingestion Rate kg/yr	Number of grams in Kilogram	Days in year	Conversion Rate	Grams per Day Age Averaged multiplied by Conversion
Vegetable	3.8	6	10.4	24	272.4	30	9.08	1000	365	2.739726027	24.87671233
Fruit	5.4	6	20.5	24	524.4	30	17.48	1000	365	2.739726027	47.89041096
Fish	6.4	6	45.8	24	1137.6	30	37.92	1000	365	2.739726027	103.890411
Milk	96.9	6	224.4	24	5967	30	198.9	1000	365	2.739726027	544.9315068
Beef	4.7	6	50.2	24	1233	30	41.1	1000	365	2.739726027	112.6027397
Swine	4.5	6	27.7	24	691.8	30	23.06	1000	365	2.739726027	63.17808219
Egg	2.3	6	14.9	24	371.4	30	12.38	1000	365	2.739726027	33.91780822
Poultry	5	6	35.8	24	889.2	30	29.64	1000	365	2.739726027	81.20547945
Water											2000
Total daily 3012.493151 Ingestion											

Table Comparing 500 mrem/yr Food DIL Concentrations to 1x10-4 Concentrations
Sorted by Radionuclide

Radionuclide	Food DILs	All concentrations in Bq/kg				Comparison shows DIL is x times the 1x10-4 concentration					
		1x10-4 using SF metho	1x10-4 using SF metho	1x10-4 using SF metho	1x10-4 using SF metho	with water and 30%	with water and 100%	without water and 30%	without water and 100%		
		th water and 3(h water and 10(h water and 10out water and 1	od contaminated	od contaminated	od contaminated	od contaminated	contaminated	contaminated	contaminated	contaminated	contaminated
Sr-90	160	1.753333333	0.526	5.233333333	1.57	91.25475285	304.1825095	30.57324841	101.910828		
I-131	170	1.246666667	0.374	3.7	1.11	136.3636364	454.5454545	45.94594595	153.1531532		
Cs-134	1200	3.25	0.975	9.666666667	2.9	369.2307692	1230.769231	124.137931	413.7931034		
Cs-137	1200	4.466666667	1.34	13.3	3.99	268.6567164	895.5223881	90.22556391	300.7518797		
Ru-103	6800	30.1	9.03	89.666666667	26.9	225.9136213	753.0454042	75.83643123	252.7881041		
Ru-106	6800	2.733333333	0.82	8.133333333	2.44	2487.804878	8292.682927	836.0655738	2786.885246		
Pu-238	2	0.99	0.297	2.943333333	0.883	2.02020202	6.734006734	0.679501699	2.265005663		
Pu-239	2	0.96	0.288	2.856666667	0.857	2.083333333	6.944444444	0.700116686	2.333722287		
Am-241	2	1.246666667	0.374	3.766666667	1.13	1.604278075	5.347593583	0.530973451	1.769911504		
Sr-89	1400	9.066666667	2.72	27.033333333	8.11	154.4117647	514.7058824	51.78791615	172.6263872		
Y-91	1200	7.1	2.13	21.166666667	6.35	169.0140845	563.3802817	56.69291339	188.976378		
Zr-95	4000	25.366666667	7.61	75.333333333	22.6	157.6872536	525.6241787	53.09734513	176.9911504		
Nb-95	12000	47.333333333	14.2	142	42.6	253.5211268	845.0704225	84.50704225	281.6901408		
Te-132	4400	6.833333333	2.05	20.366666667	6.11	643.902439	2146.341463	216.0392799	720.1309329		
I-129	56	0.52	0.156	1.543333333	0.463	107.6923077	358.974359	36.28509719	120.950324		
I-133	7000	3.8	1.14	11.3	3.39	1842.105263	6140.350877	619.4690265	2064.896755		
Ba-140	6900	7.7	2.31	22.9	6.87	896.1038961	2987.012987	301.3100437	1004.366812		
Ce-141	7200	24.666666667	7.4	73.333333333	22	291.8918919	972.972973	98.18181818	327.2727273		
Ce-144	500	3.22	0.966	9.566666667	2.87	155.2795031	517.5983437	52.26480836	174.2160279		
Np-237	4	1.836666667	0.551	5.466666667	1.64	2.177858439	7.259528131	0.731707317	2.43902439		
Np-239	2800	22.266666667	6.68	66.333333333	19.9	125.748503	419.1616766	42.21105528	140.7035176		
Pu-241	120	73.333333333	22	218	65.4	1.636363636	5.454545455	0.550458716	1.834862385		
Cm-242	19	3.05	0.915	9.066666667	2.72	6.229508197	20.76502732	2.095588235	6.985294118		
Cm-244	2	1.546666667	0.464	4.6	1.38	1.293103448	4.310344828	0.434782609	1.449275362		